

REMARKS

Rejections under 35 U.S.C. 103

Claims 1-3, 5-10, 12-15 and 17-20 stand rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,204,130 to Gardner in view of the admitted prior art, and claims 4, 11 and 16 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Gardner in view of the Admitted Prior Art (APA), and further in view of U.S. Patent No. 5,977,589 to Schloesser. Applicants respectfully disagree.

Claim 1

In the present action, the Examiner maintains that Gardner reads on "*treating said patterned silicon layer with etching residues on sidewalls thereof using a gas comprising oxygen and etching agent*" as recited in claim 1.

In particular, the Examiner notes that the declaration of Paul Yih, submitted in response to the previous Action, points out that Gardner does not describe H₂O as an etching agent, but opines that the claim doesn't require any etching during the treatment process, just oxidation, and concludes that the argument is not commensurate with the scope of the claim.

Applicants disagree with the Examiner, and respectfully remind the Examiner that claim 1 recites using an "etching agent" (i.e. treating a silicon layer "*using a gas comprising oxygen and etching agent*"). Applicants therefore respectfully submit that it is fully compliant with the scope of the claim to point out that there is no support in Gardner for the Examiner's assertion that H₂O is an etching agent.

Applicants note that the Examiner has failed to show that Gardner, or the APA, supports the Examiner's assertion that Gardner's "*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O₂ and/or H₂O)*" would in any way read or suggest treating a silicon layer "*using a gas comprising oxygen and etching agent*", in particular as recited in claim 1.

As to H₂O being used as an etching agent in the semiconductor field, the

Examiner cites two new references: JP02000106357A to Aoi and U.S. 6,207,565 to Yeh. Applicants note that, according to the USPTO examination guidelines (**MPEP 2111**), the "PTO applies to verbiage of the proposed claims the broadest reasonable meaning of the words in their ordinary usage as they would be understood by one of ordinary skill in the art, taking into account whatever enlightenment by way of definitions or otherwise that may be afforded by the written description contained in applicant's specification".

The Application teaches using: "*etching agent comprising hydrogen halide (HX), such as HF, HCl, and HBr*" and "*etching agents comprising hydride halogen*" (paragraph [0005]); "*etching agent selected from the group comprising Cl, SF₆, or HBr*" (paragraph [0013]); or "*etching agent comprises HF, HCl, or HBr*" (paragraph [0021]); and "*second etching agent is from Cl₂, SF₆, or HBr*" (paragraph [0023]).

Applicants note that, taking into account the definition the specification makes of an "etching agent", one of ordinary skill in the art would readily understand that the "etching agent" recited in claim 1 (wherein claim 1 explicitly relates to etching silicon), relates unambiguously to an agent for etching silicon (such as *HF, HCl, HBr, Cl, Cl₂, SF₆*).

Applicants respectfully submit that one of ordinary skill in the art would not have reasonably broadened the term "etching agent", recited in a method claim related to silicon etching, for example to an etching agent for etching organic material, as opposed to silicon.

Accordingly, Applicants respectfully submit to the appreciation of the Examiner that broadening the meaning of the term "etching agent", in a method claim related to silicon etching, to encompass etching agents not used for silicon but used for organic material, would clearly be a violation of the USPTO examination guidelines, and in particular MPEP 2111.

This being said, Applicants note that Aoi teaches using H₂O plasma for etching an organic film while preventing the film from being oxidized (problem and solution of the abstract). An English language translation of Aoi, provided by the Japan Patent Office's automated translation system, is enclosed for the Examiner's ease of reference. Applicants note that Aoi teaches that H₂O plasma can be used for etching an organic film, but does not disclose or suggest that H₂O plasma can be used for etching silicon.

Besides, Applicants note that Aoi teaches (paragraph [0056]) etching silicon oxide 104 using a fluorocarbon system etching gas, not H₂O plasma. Aoi however does nowhere disclose or suggest to one skilled in the Art that H₂O plasma can be used as an etching agent for silicon. Broadening the meaning of “etching agent” in claim 1 to encompass H₂O plasma can therefore not be done without violating MPEP 2111.

Besides, Gardner teaches using H₂O, not H₂O plasma. Accordingly, even broadening –in violation of MPEP 2111- the meaning of “etching agent” in claim 1 to encompass H₂O plasma (which is not in Aoi an etching agent of silicon but of organic films) would still not support the Examiner’s assertion that Gardner’s “*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O₂ and or H₂O)*” discloses or suggests in any way treating a silicon layer “*using a gas comprising oxygen and etching agent*”, as recited in claim 1.

Gardner recites that “*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O₂ and or H₂O)*”: Gardner teaches using H₂O for oxidizing polysilicon whereas, as seen above, Aoi teaches using H₂O plasma for etching an organic film while preventing the film from being oxidized. Accordingly, even if the Examiner were to maintain that H₂O plasma can somehow read on an “etching agent” for a process relating to etching silicon, Aoi teaches explicitly that the use of H₂O plasma as an etching agent prevents oxidation of the etched material, whereas Gardner explicitly teaches using H₂O for oxidizing a polysilicon block, whereby Gardner unambiguously rules out the use of plasma H₂O (i.e. of H₂O in a state where it would supposedly read on an “etching agent”).

It follows that Aoi does not provide support for the Examiner’s assertion that Gardner’s “*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O₂ and or H₂O)*” would read on treating a silicon layer “*using a gas comprising oxygen and etching agent*”, as recited in claim 1.

Yeh relates to using a mixture of H₂O and a gaseous fluorocarbon or a fluorinated hydrocarbon gas for performing an ashing step. Applicants note that “ashing” is defined, (for example in semiconductorglossary.com) as “removal (by volatilization) of organic materials (e.g. photoresist) from the wafer surface using

strongly oxidizing ambient; e.g. oxygen plasma ashing". Yeh clearly distinguishes the materials used for etching and ashing. Yeh teaches *first* performing an oxide etching step, wherein "such an oxide etch step is performed using etchants selected from the group consisting of CF_4 , CHF_3 , or similar polyfluorinated hydrocarbons" (col. 4, lines 18-20). *Then*, "after the oxide etch step, semiconductor substrate 102 is placed in an ashing environment" (col. 4, lines 29-30), wherein " H_2O and CF_4 are introduced into the ashing environment" (col. 4, lines 41-42) to remove the etching contaminants (col. 4, lines 20-23). Applicants note that one with ordinary skill in the art unambiguously understands that Yeh does not teach using the mixture of H_2O and a gaseous fluorocarbon for etching, but for ashing. Applicants note that Yeh can therefore only be deemed to suggest that the mixture of H_2O and a gaseous fluorocarbon is an "ashing agent" (for removing contaminants), not an "etching agent" (for etching silicon).

Besides, Applicants note that Yeh teaches using a mixture of H_2O and a gaseous fluorocarbon as an "ashing agent", and does not disclose or suggest that H_2O alone could be used as an "ashing agent", let alone an "etching agent". Applicants note that the Examiner has failed to show that Yeh teaches in any way that H_2O reads on an "etching agent", even more on an etching agent for etching silicon.

It derives from the above that Yeh does not provide support for the Examiner's assertion that Gardner's "*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O_2 and or H_2O)*" would read on treating a silicon layer "*using a gas comprising oxygen and etching agent*", as recited in claim 1.

Applicants respectfully submit that, as shown above, there is no justification in the art for the Examiner's assertion that Gardner's "*polysilicon block 209 is oxidized in an oxygen bearing ambient (e.g., O_2 and or H_2O)*", would read on treating a silicon layer "*using a gas comprising oxygen and etching agent*", as recited in claim 1. Such assertion therefore seems to derive only from hindsight knowledge of the language of claim 1, doubled by a desire to show, despite the lack of technical evidence that Gardner reads on claim 1. Applicants respectfully remind the Examiner that hindsight is not allowed for asserting the obviousness of a claim. Applicants note that the Examiner surprisingly ignores the fact that Gardner, Aoi and Yeh all disclose etching agents for Silicon

(hydrofluoric acid, fluorocarbon system etching gas, CF_4 , CHF_3 , or similar polyfluorinated hydrocarbons), but fail to indicate that H_2O would be an etching agent. Applicants respectfully submit that, even using hindsight, the Examiner has failed to show evidence that Gardner discloses treating a silicon layer "*using a gas comprising oxygen and etching agent*", as recited in claim 1. Accordingly, Applicants respectfully request the Examiner to withdraw the present rejection of claim 1.

Claims 7 and 14

Applicants respectfully submit that the above arguments can be used to show that Gardner, as well as the admitted prior art, fails to disclose or suggest a method as recited in claim 7, and in particular comprising "*treating said patterned silicon layer with patterns and etching residues on sidewalls thereof using a gas comprising oxygen and etching agent to thereby form an etching buffer layer conformally on the etching residues and the top surface of the patterned silicon layer*", or a method as recited in claim 14, and in particular comprising "*introducing a gas containing oxygen treatment, using a gas comprising oxygen and etching agent, to conformally form an etching buffer layer on the etching residues and the top surface of the patterned silicon layer*". Accordingly, Applicants respectfully submit that claims 7 and 14 are patentable over Gardner in view of the admitted prior art.

Claims 2-3, 5-6, 8-10, 12-13, 15 and 17-20

Claims 2-3 and 5-6 depend directly or indirectly on claim 1; claims 8-10 and 12-13 depend directly or indirectly on claim 7, and claims 15, and 17-20 depend directly on claim 14. Applicants respectfully submit that at least in view of their dependency on claims 1, 7 or 14, claims 2-3, 5-6, 8-10, 12-13, 15 and 17-20 are patentable over Gardner in view of the admitted prior art.

Claims 4, 11 and 16

Claim 4 depends on claim 1, claim 11 depends on claim 7, and claim 16 depends on claim 14. Applicants respectfully submit that the Examiner has failed to show that Schloesser discloses or suggests a method as recited in claim 1, and in particular comprising "*treating said patterned silicon layer with etching residues on sidewalls thereof using a gas comprising oxygen and etching agent to thereby form an etching buffer layer conformally on the etching residues and the top surface of the patterned silicon layer*", as recited in claim 7, and in particular comprising "*treating said patterned silicon layer with patterns and etching residues on sidewalls thereof using a gas comprising oxygen and etching agent to thereby form an etching buffer layer conformally on the etching residues and the top surface of the patterned silicon layer*", or a method as recited in claim 14, and in particular comprising "*introducing a gas containing oxygen treatment, using a gas comprising oxygen and etching agent, to conformally form an etching buffer layer on the etching residues and the top surface of the patterned silicon layer*". Accordingly, in view of the above, Applicants submit that the Examiner has failed to show that a combination of Gardner, the admitted prior art and Schloesser would have led one skilled in the art to a method as recited in claims 1, 7 or 14. Applicants therefore respectfully submit that claims 1, 7 and 14 are patentable over Gardner in view of Schloesser, and that at least in view of their dependency on claims 1, 7 or 14, claims 4, 11 and 16 are patentable over Gardner in view of the admitted prior art and further in view of Schloesser.

* * *

In view of the above, Applicants submit that the application is now in condition for allowance and respectfully urge the Examiner to pass this case to issue.

The Commissioner is authorized to charge any additional fees that may be required or credit overpayment to deposit account no. 12-0415. In particular, if this response is not timely filed, the Commissioner is authorized to treat this response as including a petition to extend the time period pursuant to 37 CFR 1.136(a) requesting an extension of time of the number of months necessary to make this response timely filed and the petition fee due in connection therewith may be charged to deposit account no. 12-0415.

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(Date of Transmission)

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Respectfully submitted,



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the approach of forming on a substrate the organic compound insulator which uses an organic component as a principal component, and the manufacture approach of the semiconductor device which patternizes the organic compound insulator which uses an organic component as a principal component.

[0002]

[Description of the Prior Art] Increase of the wiring time delay resulting from the increment in the capacity between wiring which is the parasitic capacitance during metal wiring serves as hindrance of high-performance-izing of a semiconductor integrated circuit with progress of high integration of a semiconductor integrated circuit. A wiring time delay is called so-called RC delay proportional to the product of resistance of metal wiring, and the capacity between wiring.

[0003] Therefore, in order to reduce a wiring time delay, it is required to make resistance of metal wiring small or to make capacity between wiring small.

[0004] It is possible to make small specific inductive capacity of the interlayer insulation film formed among metal wiring as an approach of making capacity between wiring small, and using a different ingredient from conventional silicon oxide as an interlayer insulation film is examined.

[0005] In the semiconductor integrated circuit which has the minimum processing dimension of 0.25 micrometers, the fluoridation silicon oxide which comes to add a fluorine is used for silicon oxide as an insulator layer. Since the specific inductive capacity of fluoridation silicon oxide is 3.3 to about 3.9 and is small compared with 4.2-4.5 of conventional silicon oxide, it is reported that reduction ***** of the capacity between wiring is effective for reduction of a wiring time delay.

[0006] However, it is clear that detailed-ization of a semiconductor integrated circuit progresses further, and it is considered to be indispensable that specific inductive capacity uses [the minimum processing dimension] 2.50 or less insulator layer with a semiconductor integrated circuit 0.13 micrometers or less in order to realize practical processing speed.

[0007] Then, examination of the low dielectric constant SOG (spin-on glass) film, the organic film, and porous membrane is performed as an insulator layer with specific inductive capacity still smaller than fluoridation silicon oxide. If the insulator layer known now is examined from a viewpoint of ingredient physical properties, since specific inductive capacity is small, the organic film is promising.

[0008] the perfluorocarbon polymer has the fluorine-carbon to carbon bond also in the organic film -- it comes out and specific inductive capacity is the smallest ingredient. The specific inductive capacity of a perfluorocarbon polymer is the minimum thing, and is about 1.9.

[0009] The approach by plasma CVD is reported as a typical approach of forming perfluorocarbon. Generally the organic compound insulator formed of plasma

CVD by being made from perfluorocarbon is called the amorphous fluorocarbon (a-CF) film in many cases.

[0010]

[Problem(s) to be Solved by the Invention] Although the organic compound insulator which uses an organic component as a principal component is proposed as an insulator layer with small specific inductive capacity as explained above, an organic compound insulator has the various problems that it explains below.

[0011] When it etches [1st] using the oxygen plasma to an organic compound insulator, there is a problem that an organic compound insulator deteriorates by the oxygen plasma. That is, an organic compound insulator oxidizes by the activity oxygen radical generated in the plasma, an unstable carbonyl compound is generated and the generated carbonyl compound pyrolyzes by heat treatment performed behind. If a carbonyl compound pyrolyzes, low-molecular gas, such as a carbon dioxide, occurs, and the low-molecular gas which occurred checks membrane formation of the barrier metal layer deposited on the crevice of an organic compound insulator etc., or makes silicon oxide or a metal membrane deposited on an organic compound insulator exfoliate from an organic compound insulator.

[0012] Since a radical occurs on the surface of an organic compound insulator and the radical and oxygen which were generated react in depositing [2nd] an organic compound insulator with a CVD method, an organic compound insulator will oxidize. The polymer which constitutes an organic compound insulator if an organic compound insulator oxidizes goes out, low-molecular gas, such as toluene, a phenol, or a carbon dioxide, occurs, and the problem of checking membrane formation of the barrier metal layer which the low-molecular gas which occurred deposits on the crevice of an organic compound insulator etc., or making silicon oxide or a metal membrane deposited on an organic compound insulator exfoliate from an organic compound insulator occurs.

[0013] If it etches into an oxidizing quality ambient atmosphere to an organic compound insulator and an organic compound insulator is patternized [3rd], the part exposed by etching in an organic compound insulator will oxidize. The polymer which constitutes an organic compound insulator as it mentioned above, when the organic compound insulator oxidized goes out, low-molecular gas occurs and the problem of checking membrane formation of the barrier metal layer which the low-molecular gas which occurred deposits on the crevice of an organic compound insulator etc., or making silicon oxide or a metal membrane deposited on an organic compound insulator exfoliate from an organic compound insulator occurs.

[0014] When depositing an organic compound insulator on the substrate film which consists [4th] of silicon oxide or a metal membrane, there is a problem that water sticks that the substrate film is a hydrophilic property to the front face of the substrate film, and the adhesion of an organic compound insulator and the substrate film deteriorates according to an operation of the water to which it stuck. If the organic compound insulator has the fluorine-carbon to carbon bond especially, the adhesion with the substrate film will fall remarkably.

[0015] When forming [5th] the silicon oxide which serves as for example, a mask

for etching, or a stopper for etching on an organic compound insulator, the part which is in contact with the silicon oxide in an organic compound insulator will oxidize. The polymer which constitutes an organic compound insulator as it mentioned above, when the organic compound insulator oxidized goes out, low-molecular gas occurs and the problem of checking membrane formation of the barrier metal layer which the low-molecular gas which occurred deposits on the crevice of an organic compound insulator etc., or making silicon oxide or a metal membrane deposited on an organic compound insulator exfoliate from an organic compound insulator occurs.

[0016] When depositing an organic compound insulator by the applying method, it is necessary 6th to heat-treat baking, biscuit ware, etc. to an organic compound insulator but, and in case it heat-treats to an organic compound insulator, an organic compound insulator will oxidize. The polymer which constitutes an organic compound insulator as it mentioned above, when the organic compound insulator oxidized goes out, low-molecular gas occurs and the problem of checking membrane formation of the barrier metal layer which the low-molecular gas which occurred deposits on the crevice of an organic compound insulator etc., or making silicon oxide or a metal membrane deposited on an organic compound insulator exfoliate from an organic compound insulator occurs.

[0017] Even if this invention etches to an organic compound insulator in view of the above, in spite of making making it an organic compound insulator not oxidize into the 1st purpose and depositing an organic compound insulator with a CVD method In spite of making making it an organic compound insulator not oxidize into the 2nd purpose and etching into an oxidizing quality ambient atmosphere to an organic compound insulator It makes into the 3rd purpose making it the part exposed by etching in an organic compound insulator not oxidize. It makes to raise the adhesion of an organic compound insulator and its substrate film into the 4th purpose. It makes into the 5th purpose making it the part which is in contact with the silicon oxide in an organic compound insulator not oxidize, when forming silicon oxide on an organic compound insulator. When you deposit an organic compound insulator by the applying method, let it be the 6th purpose to make it an organic compound insulator not oxidize in the heat treatment process over an organic compound insulator.

[0018]

[Means for Solving the Problem] The manufacture approach of the 1st semiconductor device applied to this invention in order to attain said 1st purpose is [the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, and] H₂O to an organic compound insulator. It etched by the plasma and has the process which patternizes an organic compound insulator.

[0019] In order to etch by the H₂O plasma to the organic compound insulator which uses as a principal component the organic component deposited on the substrate according to the manufacture approach of the 1st semiconductor device, it sets in the H₂O plasma, and it is O₂. Since the consistency of activity O radical is [be / it / under / plasma / comparing] very low, OH radical mainly acts on etching to an organic compound insulator. Since the oxidizing quality is very low compared with O radical, OH radical is considered that etching to an

organic compound insulator advances by the drawing of the hydrogen by OH. For this reason, the situation where a carbonyl compound is generated by oxidization of an organic compound insulator is avoided.

[0020] In order to attain said 1st purpose, the manufacture approach of the 2nd semiconductor device concerning this invention is equipped with the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, and the process which etches by CO plasma to an organic compound insulator, and patternizes an organic compound insulator.

[0021] In order to etch by CO plasma to the organic compound insulator which uses as a principal component the organic component deposited on the substrate according to the manufacture approach of the 2nd semiconductor device, it sets in CO plasma, and it is O₂. Since the consistency of activity O radical is [be / it / under / plasma / comparing] very low, CO radical mainly acts on etching to an organic compound insulator. Since the oxidizing quality is very low compared with O radical, CO radical is considered that etching to an organic compound insulator advances by the drawing of the hydrogen by CO. For this reason, the situation where a carbonyl compound is generated by oxidization of an organic compound insulator is avoided.

[0022] In order to attain said 2nd purpose, the formation approach of the 1st insulator layer concerning this invention is equipped with the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and the heat treatment process which heat-treats in a hydrogen ambient atmosphere to an organic compound insulator.

[0023] In order to heat-treat in a hydrogen ambient atmosphere to the organic compound insulator formed by the CVD method according to the formation approach of the 1st insulator layer, the radical and hydrogen in an organic compound insulator react, and it is -CF₂H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0024] In the formation approach of the 1st insulator layer, the CVD method in an insulator layer deposition process is a plasma-CVD method, and as for a heat treatment process, it is desirable to include the process which heat-treats in a hydrogen ambient atmosphere to an organic compound insulator, without putting the deposited organic compound insulator to an oxidizing atmosphere.

[0025] In order to attain said 2nd purpose, the formation approach of the 2nd insulator layer concerning this invention is equipped with the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and the plasma treatment process which performs hydrogen plasma treatment to an organic compound insulator.

[0026] In order to perform hydrogen plasma treatment to the organic compound insulator formed by the CVD method according to the formation approach of the 2nd insulator layer, the radical and hydrogen radical in an organic compound insulator react, and it is -CF₂H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0027] In the formation approach of the 2nd insulator layer, the CVD method in an insulator layer deposition process is a plasma-CVD method, and as for a

plasma treatment process, it is desirable to include the process which performs hydrogen plasma treatment to an organic compound insulator, without putting the deposited organic compound insulator to an oxidizing atmosphere.

[0028] In order to attain said 2nd purpose, the formation approach of the 3rd insulator layer concerning this invention has like ion grouting which performs heat treatment, after pouring in a hydrogen ion to an organic compound insulator, the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and.

[0029] After pouring in a hydrogen ion to the organic compound insulator formed by the CVD method, in order to perform heat treatment according to the formation approach of the 3rd insulator layer, the radical and hydrogen in an organic compound insulator react, and it is -CF2H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0030] In the formation approach of the 3rd insulator layer, the CVD method in an insulator layer deposition process is a plasma-CVD method, and it is as desirable as ion grouting to include the process which pours in a hydrogen ion to an organic compound insulator, without putting the deposited organic compound insulator to an oxidizing atmosphere.

[0031] In order to attain said 3rd purpose, the formation approach of the 4th insulator layer concerning this invention is equipped with the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to an organic compound insulator, and patternizes an organic compound insulator, and the process which heat-treats in a hydrogen ambient atmosphere to the patternized organic compound insulator.

[0032] It is returned by hydrogen and the carbonyl group generated in the organic compound insulator in order to heat-treat in a hydrogen ambient atmosphere according to the formation approach of the 4th insulator layer, after etching into an oxygen ambient atmosphere to an organic compound insulator is CH2. Since it becomes, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable.

[0033] In order to attain said 3rd purpose, the formation approach of the 5th insulator layer concerning this invention is equipped with the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to an organic compound insulator, and patternizes an organic compound insulator, and the process which performs hydrogen plasma treatment to the patternized organic compound insulator.

[0034] It is returned by hydrogen and the carbonyl group generated in the organic compound insulator in order to perform hydrogen plasma treatment according to the formation approach of the 5th insulator layer, after etching into an oxygen ambient atmosphere to an organic compound insulator is CH2. Since it becomes, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable.

[0035] The formation approach of the 6th insulator layer which starts this

invention in order to attain said 3rd purpose is equipped with the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to an organic compound insulator, and patternizes an organic compound insulator, and the process which performs heat treatment after pouring in a hydrogen ion to the patternized organic compound insulator.

[0036] It is returned by hydrogen and the carbonyl group generated in the organic compound insulator in order according to the formation approach of the 6th insulator layer to pour in a hydrogen ion and to perform heat treatment after that, after etching into an oxygen ambient atmosphere to an organic compound insulator is CH₂. Since it becomes, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable.

[0037] In order to attain said 4th purpose, the formation approach of the 7th insulator layer concerning this invention is equipped with the process which deposits the organic compound insulator which uses an organic component as a principal component on the process which heat-treats in a hydrogen ambient atmosphere to the substrate film formed on the substrate, and the substrate film with which heat treatment in a hydrogen ambient atmosphere was performed.

[0038] According to the formation approach of the 7th insulator layer, in order to heat-treat in a hydrogen ambient atmosphere to the substrate film, the silanol group which constitutes the substrate film is returned by hydrogen. - Since it is set to SiH or the oxide of the metal which constitutes the substrate film changes to a metaled hydride, the front face of the substrate film changes to hydrophobicity.

[0039] In order to attain said 4th purpose, the formation approach of the 8th insulator layer concerning this invention is equipped with the process which performs hydrogen plasma treatment to the substrate film formed on the substrate, and the process which deposits the organic compound insulator which uses an organic component as a principal component on the substrate film with which hydrogen plasma heat treatment was performed.

[0040] According to the formation approach of the 8th insulator layer, in order to perform hydrogen plasma treatment to the substrate film, the silanol group which constitutes the substrate film is returned by hydrogen. - Since it is set to SiH or the oxide of the metal which constitutes the substrate film changes to a metaled hydride, the front face of the substrate film changes to hydrophobicity.

[0041] In order to attain said 4th purpose, the formation approach of the 9th insulator layer concerning this invention is equipped with the process which pours in carbon ion to the substrate film formed on the substrate, and the process which deposits the organic compound insulator which uses an organic component as a principal component on the substrate film with which carbon ion was poured in.

[0042] Since according to the formation approach of the 9th insulator layer it changes to association with the atom and carbon atom with which association with the atom and hydroxyl group which constitute the substrate film constitutes the substrate film in order to pour carbon ion into the substrate film, while compatibility with an organic compound insulator becomes high, the front face of the substrate film changes to hydrophobicity.

[0043] In order to attain said 4th purpose, the formation approach of the 10th insulator layer concerning this invention is equipped with the process which deposits the organic compound insulator which uses an organic component as a principal component on the process which performs heat treatment, and the substrate film with which heat treatment after hydrogen ion impregnation was performed after pouring in a hydrogen ion to the substrate film formed on the substrate.

[0044] In order according to the formation approach of the 10th insulator layer to heat-treat to the substrate film after pouring in a hydrogen ion, the silanol group which constitutes the substrate film is returned by hydrogen. - Since it is set to SiH or the oxide of the metal which constitutes the substrate film changes to a metaled hydride, the front face of the substrate film changes to hydrophobicity.

[0045] The formation approach of the 11th insulator layer which starts this invention in order to attain said 5th purpose deposited organic component content silicon oxide by the plasma-CVD method which uses alkoxy silane as a raw material and is performed under oxidizer nonexistence the process which deposits on a substrate the organic film which uses an organic component as a principal component, and on the organic film, and is equipped with the process which forms the insulator layer which consists of organic film and organic component content silicon oxide.

[0046] In order according to the formation approach of the 11th insulator layer to use alkoxy silane for a raw material and to perform a plasma-CVD method on an organic compound insulator, a polymerization reaction occurs in the bottom of the nonexistence of an oxidizer. Therefore, since organic component content silicon oxide can be formed by the plasma CVD performed by oxidizer nonexistence-ization, oxidation of an organic compound insulator can be prevented.

[0047] The formation approach of the 12th insulator layer which starts this invention in order to attain said 5th purpose deposited organic component content silicon oxide by the plasma-CVD method which uses alkoxy silane and a silane as a raw material, and is performed under oxidizer nonexistence the process which deposits on a substrate the organic film which uses an organic component as a principal component, and on the organic film, and is equipped with the process which forms the insulator layer which consists of organic film and organic component content silicon oxide.

[0048] In order according to the formation approach of the 12th insulator layer to use alkoxy silane and a silane for a raw material and to perform a plasma-CVD method on an organic compound insulator, a polymerization reaction occurs in the bottom of the nonexistence of an oxidizer. Therefore, since organic component content silicon oxide can be formed by the plasma CVD performed by oxidizer nonexistence-ization, oxidation of an organic compound insulator can be prevented.

[0049] In order to attain said 6th purpose, the formation approach of the 13th insulator layer concerning this invention is equipped with the process which applies the ingredient which uses an organic component as a principal component, and forms the spreading film on a substrate, and the process which forms the organic compound insulator which performs baking and biscuit ware into a reducing atmosphere, and consists of spreading film to the spreading film.

[0050] According to the formation approach of the 13th insulator layer, baking and biscuit ware are performed into a reducing atmosphere to the spreading film formed by applying the ingredient which uses an organic component as a principal component, and since the organic compound insulator which consists of spreading film is formed, oxidation of an organic compound insulator can be controlled.

[0051]

[Embodiment of the Invention] (1st operation gestalt) As 1st operation gestalt of this invention, it is H₂O to the organic compound insulator which uses an organic component as a principal component, for example, the organic compound insulator which has the Pori (allyl compound ether) structure. The manufacture approach of the semiconductor device equipped with the process which performs etching using the plasma is explained referring to drawing 1 (a) - (c) drawing 2 (a) - (c) and drawing 3 (a) - (c).

[0052] First, as shown in drawing 1 (a), after forming the silicon nitride 102 which protects the 1st metal wiring 101 in the etching process performed behind and which has 50nm thickness, for example after the 1st metal wiring 101 formed on the semi-conductor substrate 100, while having 300nm thickness, the 1st organic film 103 which uses an organic component as a principal component is deposited on this silicon nitride 102. next, the organic 1st film 103 top -- for example, the 2nd organic film 105 which uses an organic component as a principal component while having 300nm thickness on this silicon oxide 104 by the plasma-CVD method, after depositing the silicon oxide 104 which has 100nm thickness -- depositing -- after that -- this -- the titanium nitride film 106 which has 50nm thickness is deposited on the 2nd organic film 105.

[0053] Although not limited especially about the deposition approach of the 1st and 2nd organic film 103 and 105, the organic film which has the Pori (allyl compound ether) structure, for example is formed by the applying method. That is, after applying to the thickness of 300nm the organic film which has the Pori (allyl compound ether) structure and performing baking by the hot plate for 1 minute in 1 minute and under the temperature of 250 degrees C under the temperature of 150 degrees C to the bottom of nitrogen-gas-atmosphere mind, respectively, in the interior of an electric furnace, the biscuit ware for 60 minutes is performed for nitrogen gas at the temperature of 400 degrees C with a sink under reduced pressure.

[0054] Next, as shown in drawing 1 (b), after forming the 1st resist pattern 107 which has opening for wiring gutter formation according to a lithography process on the titanium nitride film 106, dry etching is performed to the titanium nitride film 106 by using this 1st resist pattern 107 as a mask, and as shown in drawing 1 (c), the mask pattern 108 which consists of titanium nitride film 106 is formed.

[0055] Next, after forming the 2nd resist pattern 109 which has opening for contact hole formation according to a lithography process on the 2nd organic film 105, without removing the 1st resist pattern 107, to the 2nd organic film 105, dry etching using the H₂O plasma is performed, and as shown in drawing 2 (a), 2nd [which has opening for contact hole formation] patternized organic film 105A is formed. In this case, since both the organic film 105, and the 2nd resist pattern 107 and 2nd resist pattern 109 are using the organic component as the

principal component and that of the etching rate to the 2nd organic film 105 and the etching rate to the 1st and 2nd resist patterns 107 and 109 are almost equal, the 1st resist pattern 107 and 2nd resist pattern 109 are removed by the dry etching process over the 2nd organic film 105. [1st]

[0056] Next, while using 2nd patternized organic film 105A as a mask, dry etching is performed to silicon oxide 104 using the etching gas of a fluorocarbon system, and as shown in drawing 2 (b), patternized silicon oxide 104A which has opening for contact hole formation is formed.

[0057] Next, the 1st organic film 103 is received by using as a mask silicon oxide 104A patternized as opposed to 2nd organic film 105A patternized as a mask in the mask pattern 108. H2O Dry etching using the plasma is performed, respectively, and as shown in drawing 2 (c), while forming a wiring gutter 111 in 2nd patternized organic film 105A, 1st [which has a contact hole 110] patternized organic film 103A is formed.

[0058] Next, dry etching is performed to the silicon nitride 102 by using patternized silicon oxide 104A as a mask, and as shown in drawing 3 (a), while forming patternized silicon nitride 102A, the 1st metal wiring 101 is exposed to a contact hole 110.

[0059] Next, as shown in drawing 3 (b), the whole surface is covered and a metal membrane 113 is deposited so that a contact hole 110 and a wiring gutter 111 may be buried with the wall surface of a contact hole 110 and a wiring gutter 111, after depositing the adhesion layer 112 which consists of titanium nitride which has 50nm thickness. Especially the presentation of a metal membrane 113 is not limited, but can use copper, aluminum, gold, silver, nickel, cobalt, tungstens, or these alloys.

[0060] Next, as shown in drawing 3 (c), it removes by the CMP method and the contact 115 which consists of a metal membrane 113 which connects the 2nd metal wiring 114 which consists of a metal membrane 113, and the 1st metal wiring 101 and the 2nd metal wiring 114 is formed for the adhesion layer 112, the metal membrane 113, and mask pattern 108 which have been deposited on 2nd patternized organic film 105A.

[0061] By the way, in the etching process over the 1st organic film 103 and the 2nd organic film 105, although carried out in the former by reactive ion etching which makes oxygen etching gas, since reactivity is high, in case the organic film is etching, degradation of the membranous quality by oxygen produces it to oxygen. That is, since the organic film oxidized by the activity oxygen radical generated in the plasma, the unstable carbonyl compound was generated and the generated carbonyl compound pyrolyzed by heat treatment of a back process, there was un-arranging [that degasifying occurred].

[0062] On the other hand, it is H2O like the 1st operation gestalt. H2O used as etching gas By the plasma method It is H2O if the 1st organic film 103 and the 2nd organic film 105 are etched. It is under [plasma] setting. O2 Since the consistency of activity O radical is very low, OH radical mainly acts [be / it / under / plasma / comparing] on etching to the 1st and 2nd organic film 103 and 105. For this reason, an etch rate is O2. It is O2 although it is late compared with the case where the plasma is used. It is about [in the case of using the plasma] 2/3, and is a rate practical enough.

[0063] Since the oxidizing quality is very low compared with O radical, OH

radical is considered that etching to the 1st and 2nd organic film 103 and 105 advances by the drawing of the hydrogen by OH. That is, OH radical reacts with H atom combined with C atom which constitutes the polymer of the organic film, and it is H₂O. Since it is generated and generated H₂O is desorbed from C atom, an uncombined hand is formed in C atom. When other OH radicals combine with the uncombined hand of C atom, the low molecular weight compound which consists of alcohol or an aldehyde compound is generated and the generated low molecular weight compound is desorbed from the polymer of the organic film, it is thought that etching to the organic film advances.

[0064] Therefore, the situation which the 1st and 2nd organic film 103 and 105 oxidizes, a carbonyl compound is generated, and low-molecular gas generates can be reduced greatly.

[0065] When etched by the H₂O plasma to the 1st and 2nd organic film 103 and 105, the shape of a quirk of the request which has an anisotropy was able to be formed in the organic film.

[0066] Moreover, when the organic film after etching was evaluated with the infrared spectrum (FTIR), the absorption peak based on a carbonyl group was below an observation limitation.

[0067] (2nd operation gestalt) The manufacture approach of the semiconductor device equipped with the process which etches by CO plasma to the organic compound insulator which has as 2nd operation gestalt of this invention, the organic compound insulator, for example, Pori (allyl compound ether) structure, which uses an organic component as a principal component, is explained.

[0068] It is only that etching processes [as opposed to / as compared with the 1st operation gestalt / the 1st and 2nd organic film 103 and 105 in the 2nd operation gestalt] differ. That is, in the etching process over the 1st and 2nd organic film 103 and 105, it carries out by the CO plasma method using CO as etching gas.

[0069] Like the 2nd operation gestalt, when the CO plasma method using CO as etching gas is performed, it sets in CO plasma and is O₂. Since the consistency of activity O radical is very low, CO radical mainly acts [be / it / under / plasma / comparing] on etching to the 1st and 2nd organic film 103 and 105. For this reason, an etch rate is O₂. It is O₂ although it is late compared with the case where the plasma is used. It is about [in the case of using the plasma] 1/2, and is a rate practical enough.

[0070] Since the oxidizing quality is very low compared with O radical, CO radical is considered that etching to the 1st and 2nd organic film 103 and 105 advances by the drawing of the hydrogen by CO. That is, when it combines with C atom with which CO radical constitutes the polymer of the organic film, and the low molecular weight compound which consists of alcohol or an aldehyde compound is generated and the generated low molecular weight compound is desorbed from the polymer of the organic film, it is thought that etching to the organic film advances.

[0071] Therefore, the situation which the 1st and 2nd organic film 103 and 105 oxidizes, a carbonyl compound is generated, and low-molecular gas generates can be reduced greatly.

[0072] According to the 2nd operation gestalt, since it is strong compared with association with H and O, compared with the 1st operation gestalt, extent which O radical contributes to etching is low. [in / in association with C and O in CO

radical / OH radical] for this reason, the phenomenon which low-molecular gas generates although an etch rate is inferior a little -- much more -- generating -- hard -- ** -- **

[0073] When etched by CO plasma to the 1st and 2nd organic film 103 and 105, the shape of a quirk of the request which has an anisotropy was able to be formed in the organic film.

[0074] Moreover, when the organic film after etching was evaluated with the infrared spectrum (FTIR), the absorption peak based on a carbonyl group was below an observation limitation.

[0075] (3rd operation gestalt) The formation approach of the organic compound insulator which heat-treats under a hydrogen ambient atmosphere is explained to the organic compound insulator, for example, the amorphous fluorocarbon film, which uses as a principal component the organic component formed by the plasma-CVD method as 3rd operation gestalt of this invention.

[0076] Heat treatment of a 60-minute about room is performed under the temperature of 400 degrees C into a hydrogen ambient atmosphere, without putting into an oxygen ambient atmosphere to the deposited amorphous fluorocarbon film by the plasma-CVD method, after depositing an organic compound insulator, for example, the amorphous fluorocarbon film, on a semiconductor substrate.

[0077] In organic compound insulators, such as amorphous fluorocarbon film formed by the plasma-CVD method, a radical exists in an organic compound insulator immediately after membrane formation. For the reason, the fluorocarbon which is the raw material of the amorphous fluorocarbon film is CF₂ in the plasma. CF₂ which dissociated to the radical and was dissociated Since membrane formation advances by a radical's carrying out a polymerization and forming a polymer, a polymer is -CF₂. It is because termination is carried out by the radical radical.

[0078] Thus, since a radical exists in the organic compound insulator immediately after forming by the plasma-CVD method, if an organic compound insulator is put to an oxidizing quality ambient atmosphere, since a radical and oxygen will react, an organic compound insulator oxidizes, and in the heat treatment process performed after that, low-molecular gas, such as toluene, a phenol, or a carbon dioxide, occurs from an organic compound insulator.

[0079] However, in order to heat-treat in a hydrogen ambient atmosphere, without putting into an oxygen ambient atmosphere in the 3rd operation gestalt to the organic compound insulator immediately after forming by the plasma-CVD method, as it is shown in the following reaction formulas, the radical and hydrogen in an organic compound insulator react, and it is -CF₂H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0080] - According to CF₂^{*}+H₂ ->-CF₂H+H^{*}, therefore the 3rd operation gestalt, it is hard coming to generate low-molecular gas from an organic compound insulator.

[0081] (4th operation gestalt) The formation approach of the organic compound insulator which processes by the hydrogen plasma to the organic compound insulator, for example, the amorphous fluorocarbon film, which uses as a principal component the organic component formed by the plasma-CVD method as 4th operation gestalt of this invention is explained.

[0082] Without putting into an oxygen ambient atmosphere to the deposited amorphous fluorocarbon film by the plasma-CVD method, after depositing an organic compound insulator, for example, the amorphous fluorocarbon film, on a semi-conductor substrate, it is the degree of vacuum of 5Torr(s), for example, and hydrogen plasma treatment is performed on condition that the substrate temperature of 50 degrees C.

[0083] In order to perform hydrogen plasma treatment, without putting into an oxygen ambient atmosphere to the organic compound insulator immediately after forming by the plasma-CVD method according to the 4th operation gestalt, as it is shown in the following reaction formulas, the radical and hydrogen radical in an organic compound insulator react, and it is -CF2H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0084] - According to $\text{CF}_2^* + \text{H}^* \rightarrow \text{-CF}_2\text{H}$, therefore the 4th operation gestalt, it is hard coming to generate low-molecular gas from an organic compound insulator.

[0085] since high energy is needed in the 3rd operation gestalt in order that -CF_2^* and a hydrogen content child (H_2) may react, but a reaction occurs with low energy in the 4th operation gestalt in order that -CF_2^* and a hydrogen radical (H^*) may react -- the 3rd operation gestalt -- comparing -- low temperature -- and a radical can be reduced in a short time.

[0086] But since the reaction of a hydrogen radical and the unsaturated bond of a polymer advances, depending on the conditions of plasma treatment, it may be accompanied by the rise of specific inductive capacity.

[0087] (5th operation gestalt) The formation approach of the organic compound insulator which heat-treats after pouring in a hydrogen ion is explained to the organic compound insulator, for example, the amorphous fluorocarbon film, which uses as a principal component the organic component formed by the plasma-CVD method as 5th operation gestalt of this invention.

[0088] Without putting into an oxygen ambient atmosphere to the deposited amorphous fluorocarbon film by the plasma-CVD method, after depositing an organic compound insulator, for example, the amorphous fluorocarbon film, on a semi-conductor substrate, a hydrogen ion is poured in and heat treatment of a 60-minute about room is performed under after that, for example, the temperature of 400 degrees C.

[0089] In order to heat-treat without putting into an oxygen ambient atmosphere to the organic compound insulator immediately after forming by the plasma-CVD method according to the 5th operation gestalt after pouring in a hydrogen ion, the radical and hydrogen in an organic compound insulator react, and it is -CF2H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen.

[0090] Since a hydrogen atom is especially spread in an organic compound insulator according to the 5th operation gestalt in order to pour in a hydrogen ion into an organic compound insulator, generating of a radical can be controlled more certainly.

[0091] Moreover, since it becomes possible to pour in the hydrogen ion of an amount set by the concentration of the radical which exists in an organic compound insulator, there is no possibility that an organic compound insulator may have degradation caused by superfluous hydrogen.

[0092] But it originates in the charge up by impregnation of a hydrogen ion, and there is a possibility that a damage may arise in a device.

[0093] (6th operation gestalt) After etching into an oxidizing quality ambient atmosphere to the organic compound insulator which has as 6th operation gestalt of this invention, the organic compound insulator, for example, Pori (allyl compound ether) structure, which uses an organic component as a principal component, the formation approach of the organic compound insulator which heat-treats under a hydrogen ambient atmosphere is explained to the part exposed by etching in an organic compound insulator.

[0094] Like the 1st and 2nd organic film 103 and 105 in the 1st operation gestalt as the formation approach of an organic compound insulator After applying to the thickness of 300nm the organic film which has the Pori (allyl compound ether) structure, baking by the hot plate is set under nitrogen-gas-atmosphere mind. After carrying out for 1 minute in 1 minute and under the temperature of 250 degrees C under the temperature of 150 degrees C, respectively, in the interior of an electric furnace, the biscuit ware for 60 minutes is performed for nitrogen gas at the temperature of 400 degrees C with a sink under reduced pressure.

[0095] Next, after etching to an organic compound insulator by the reactive-ion-etching method which makes oxygen etching gas unlike the 1st operation gestalt, heat treatment of a 60-minute about room is performed under the temperature of 400 degrees C into a hydrogen ambient atmosphere.

[0096] If etching using oxygen as etching gas is performed to an organic compound insulator, since reactivity is high, in case an organic compound insulator is etching, degradation of the membranous quality by oxygen will produce it to oxygen. That is, since an organic compound insulator oxidizes by the activity oxygen radical generated in the plasma, an unstable carbonyl compound is generated and the generated carbonyl compound pyrolyzes by heat treatment of a back process, there is a possibility that low-molecular gas may occur.

[0097] However, it is returned by hydrogen and the carbonyl group ($>\text{C}=\text{O}$) generated in the organic compound insulator since it heat-treated in the hydrogen ambient atmosphere after performing etching which makes oxygen etching gas to an organic compound insulator in the 6th operation gestalt is CH_2 . It becomes. For this reason, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable.

[0098] When the organic compound insulator after etching was evaluated with the infrared spectrum (FTIR), it has checked that the carbonyl group was decreasing.

[0099] (7th operation gestalt) After etching into an oxidizing quality ambient atmosphere to the organic compound insulator which has as 7th operation gestalt of this invention, the organic compound insulator, for example, Pori (allyl compound ether) structure, which uses an organic component as a principal component, the formation approach of the organic compound insulator which processes by the hydrogen plasma to the part exposed by etching in an organic compound insulator is explained.

[0100] Like the 1st and 2nd organic film 103 and 105 in the 1st operation gestalt

as the formation approach of an organic compound insulator After applying to the thickness of 300nm the organic film which has the Pori (allyl compound ether) structure, baking by the hot plate is set under nitrogen-gas-atmosphere mind. After carrying out for 1 minute in 1 minute and under the temperature of 250 degrees C under the temperature of 150 degrees C, respectively, in the interior of an electric furnace, the biscuit ware for 60 minutes is performed for nitrogen gas at the temperature of 400 degrees C with a sink under reduced pressure.

[0101] Next, after etching to an organic compound insulator by the reactive-ion-etching method which makes oxygen etching gas unlike the 1st operation gestalt, it is the degree of vacuum of 5Torr(s), and hydrogen plasma treatment is performed on condition that the substrate temperature of 50 degrees C.

[0102] It is returned by hydrogen and the carbonyl group ($>\text{C}=\text{O}$) generated in the organic compound insulator since according to the 7th operation gestalt hydrogen plasma treatment was performed after performing etching which makes oxygen etching gas to an organic compound insulator is CH_2 . It becomes. For this reason, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable.

[0103] When the organic compound insulator after etching was evaluated with the infrared spectrum (FTIR), it has checked that the carbonyl group was decreasing.

[0104] (8th operation gestalt) The formation approach of the organic compound insulator which heat-treats after pouring in a hydrogen ion is explained to the part exposed by etching in an organic compound insulator after etching into an oxidizing quality ambient atmosphere to the organic compound insulator which has as 8th operation gestalt of this invention, the organic compound insulator, for example, Pori (allyl compound ether) structure, which uses an organic component as a principal component.

[0105] Like the 1st and 2nd organic film 103 and 105 in the 1st operation gestalt as the formation approach of an organic compound insulator After applying to the thickness of 300nm the organic film which has the Pori (allyl compound ether) structure, baking by the hot plate is set under nitrogen-gas-atmosphere mind. After carrying out for 1 minute in 1 minute and under the temperature of 250 degrees C under the temperature of 150 degrees C, respectively, in the interior of an electric furnace, the biscuit ware for 60 minutes is performed for nitrogen gas at the temperature of 400 degrees C with a sink under reduced pressure.

[0106] Next, after etching to an organic compound insulator by the reactive-ion-etching method which makes oxygen etching gas unlike the 1st operation gestalt, a hydrogen ion is poured in and heat treatment of a 60-minute about room is performed under after that, for example, the temperature of 400 degrees C.

[0107] It is returned by hydrogen and the carbonyl group ($>\text{C}=\text{O}$) generated in the organic compound insulator since according to the 8th operation gestalt the hydrogen ion was poured in and heat treatment was performed after that after performing etching which makes oxygen etching gas to an organic compound insulator is CH_2 . It becomes. For this reason, even if it heat-treats to an organic compound insulator in a back process, the situation which a carbonyl compound

pyrolyzes and low-molecular gas generates is avoidable.

[0108] When the organic compound insulator after etching was evaluated with the infrared spectrum (FTIR), it has checked that the carbonyl group was decreasing.

[0109] (9th operation gestalt) After heat-treating under a hydrogen ambient atmosphere to the front face of a semi-conductor substrate as 9th operation gestalt of this invention, the formation approach of the organic compound insulator which deposits the organic compound insulator which uses an organic component as a principal component is explained.

[0110] After depositing silicon oxide for example, by the plasma-CVD method on a semi-conductor substrate, to this silicon oxide, heat treatment of a 60-minute about room is performed under the temperature of 400 degrees C into a hydrogen ambient atmosphere, for example, the organic compound insulator which uses an organic component as a principal component is deposited by the applying method or the plasma-CVD method on silicon oxide after an appropriate time.

[0111] Since a silanol group exists in the front face of the silicon oxide immediately after membrane formation and the front face of silicon oxide has become a hydrophilic property by this silanol group, when depositing an organic compound insulator on silicon oxide and depositing an organic compound insulator especially by the applying method, the adhesion of an organic compound insulator and silicon oxide is spoiled.

[0112] However, in the 9th operation gestalt, since an organic compound insulator is deposited on silicon oxide after heat-treating in a hydrogen ambient atmosphere to silicon oxide, the adhesion of an organic compound insulator and silicon oxide improves. That is, if it heat-treats in a hydrogen ambient atmosphere to silicon oxide, the silanol group (-SiOH) which exists on the surface of silicon oxide will be returned by hydrogen. - Since it is set to SiH and the front face of silicon oxide changes to hydrophobicity, the adhesion of an organic compound insulator and silicon oxide improves.

[0113] If it heat-treats under a hydrogen ambient atmosphere to silicon oxide, since it is removable to the silanol and moisture in silicon oxide, the adhesion of an organic compound insulator and silicon oxide can be raised greatly.

[0114] In depositing an organic compound insulator by the plasma-CVD method on the silicon oxide to which heat treatment in a hydrogen ambient atmosphere was performed, it exists on the surface of silicon oxide. - Since SiH and an organic radical react and Si-C association is formed, the adhesion of an organic compound insulator and silicon oxide improves further.

[0115] In addition, if an organic compound insulator is deposited after it heat-treats under a hydrogen ambient atmosphere to the front face of a metal membrane also when depositing an organic compound insulator on the metal membrane which replaces with this, for example, consists of an aluminium alloy etc. although the 9th operation gestalt explained the case where the adhesion of silicon oxide and an organic compound insulator was raised, its adhesion of an organic compound insulator and a metal membrane will improve. If it heat-treats under a hydrogen ambient atmosphere to the front face of a metal membrane, since a metaled oxide (Me-O) will change to a metaled hydride (Me-H), the reason is for the front face of a metal membrane to change to hydrophobicity.

[0116] (10th operation gestalt) After performing hydrogen plasma treatment to the front face of a semi-conductor substrate as 10th operation gestalt of this invention, the formation approach of the organic compound insulator which deposits the organic compound insulator which uses an organic component as a principal component is explained.

[0117] After depositing silicon oxide for example, by the plasma-CVD method on a semi-conductor substrate, as opposed to this silicon oxide, it is the degree of vacuum of 5Torr(s), and hydrogen plasma treatment is performed on condition that the substrate temperature of 50 degrees C, and the organic compound insulator which uses an organic component as a principal component is deposited by the applying method or the plasma-CVD method on silicon oxide after an appropriate time.

[0118] Since according to the 10th operation gestalt an organic compound insulator is deposited on silicon oxide after performing hydrogen plasma treatment to silicon oxide, the adhesion of an organic compound insulator and silicon oxide improves. That is, if hydrogen plasma treatment is performed to silicon oxide, the silanol group (-SiOH) which exists on the surface of silicon oxide will be returned by hydrogen. - Since it is set to SiH and the front face of silicon oxide changes to hydrophobicity, the adhesion of an organic compound insulator and silicon oxide improves.

[0119] Since the 10th operation gestalt performs hydrogen plasma treatment to the front face of silicon oxide, it can change the front face of silicon oxide to hydrophobicity for a short time.

[0120] In depositing an organic compound insulator by the plasma-CVD method on the silicon oxide to which hydrogen plasma treatment was performed, it exists on the surface of silicon oxide. - Since SiH and an organic radical react and Si-C association is formed, the adhesion of an organic compound insulator and silicon oxide improves further.

[0121] In addition, if an organic compound insulator is deposited after it performs hydrogen plasma treatment to the front face of a metal membrane also when depositing an organic compound insulator on the metal membrane which replaces with this, for example, consists of an aluminium alloy etc. although the 10th operation gestalt explained the case where the adhesion of silicon oxide and an organic compound insulator was raised, its adhesion of an organic compound insulator and a metal membrane will improve. If hydrogen plasma treatment is performed to the front face of a metal membrane, since a metaled oxide (Me-O) will change to a metaled hydride (Me-H), the reason is for the front face of a metal membrane to change to hydrophobicity.

[0122] (11th operation gestalt) After pouring in carbon ion to the front face of a semi-conductor substrate as 11th operation gestalt of this invention, heat treatment is performed and the formation approach of the organic compound insulator which deposits the organic compound insulator which uses an organic component as a principal component is explained after that.

[0123] On a semi-conductor substrate, silicon oxide is deposited for example, by the plasma-CVD method. After pouring in carbon ion to silicon oxide, heat treatment of a 60-minute about room is performed under the temperature of 400 degrees C, and the organic compound insulator which uses an organic component as a principal component is deposited by the applying method or the

plasma-CVD method on silicon oxide after an appropriate time.

[0124] Since according to the 11th operation gestalt heat treatment is performed and an organic compound insulator is deposited on silicon oxide after that after pouring in carbon ion to silicon oxide, the adhesion of an organic compound insulator and silicon oxide improves. That is, if carbon ion is poured in to silicon oxide, the silanol group which exists on the surface of silicon oxide (-SiOH) - Since the front face of silicon oxide changes to hydrophobicity while compatibility with an organic compound insulator becomes high in order to change to SiC, the adhesion of an organic compound insulator and silicon oxide improves.

[0125] Since the organic radical which is the carbon of Si-C association and the raw material of a polymer which exist on the surface of silicon oxide reacts in depositing an organic compound insulator by the plasma-CVD method on the silicon oxide which poured in carbon ion, the adhesion of an organic compound insulator and silicon oxide improves further.

[0126] In addition, in the 11th operation gestalt, to pour carbon ion into silicon oxide, subsequent heat treatment is not necessarily required [after pouring in carbon ion, it heat-treated but].

[0127] (12th operation gestalt) After pouring in a hydrogen ion to the front face of a semi-conductor substrate as 12th operation gestalt of this invention, heat treatment is performed and the formation approach of the organic compound insulator which deposits the organic compound insulator which uses an organic component as a principal component is explained after that.

[0128] On a semi-conductor substrate, silicon oxide is deposited for example, by the plasma-CVD method. After pouring in a hydrogen ion to silicon oxide, heat treatment of a 60-minute about room is performed under the temperature of 400 degrees C, and the organic compound insulator which uses an organic component as a principal component is deposited by the applying method or the plasma-CVD method on silicon oxide after an appropriate time.

[0129] Since according to the 12th operation gestalt heat treatment is performed and an organic compound insulator is deposited on silicon oxide after that after pouring in a hydrogen ion to silicon oxide, the adhesion of an organic compound insulator and silicon oxide improves. That is, if it heat-treats to silicon oxide after pouring in a hydrogen ion, the silanol group (-SiOH) which exists on the surface of silicon oxide will be returned by hydrogen. - Since it is set to SiH and the front face of silicon oxide changes to hydrophobicity, the adhesion of an organic compound insulator and silicon oxide improves.

[0130] Although it can control the stress generated in silicon oxide compared with the 11th operation gestalt since the 12th operation gestalt pours in a hydrogen ion to the front face of silicon oxide, and it can form Si-H association only in the **** front face of silicon oxide, in respect of improvement in adhesion, the direction of the 11th operation gestalt is excellent a little.

[0131] In depositing an organic compound insulator by the plasma-CVD method on the silicon oxide to which heat treatment was performed after a hydrogen ion is poured in, it exists on the surface of silicon oxide. - Since SiH and an organic radical react and Si-C association is formed, the adhesion of an organic compound insulator and silicon oxide improves further.

[0132] In addition, if the 12th operation gestalt heat-treats after it pours in a

hydrogen ion to the front face of a metal membrane and an organic compound insulator is deposited after that also when depositing an organic compound insulator on the metal membrane which replaces with this, for example, consists of an aluminium alloy etc. although it explained the case where the adhesion of silicon oxide and an organic compound insulator was raised, its adhesion of an organic compound insulator and a metal membrane will improve. If it heat-treats after pouring in a hydrogen ion to the front face of a metal membrane, since a metaled oxide (Me-O) will change to a metaled hydride (Me-H), the reason is for the front face of a metal membrane to change to hydrophobicity.

[0133] (13th operation gestalt) As 13th operation gestalt of this invention, on the organic compound insulator which uses an organic component as a principal component, alkoxy silane is used as a raw material and the plasma CVD performed by oxidizer nonexistence-ization explains the formation approach of the insulator layer which forms silicon oxide.

[0134] On a semi-conductor substrate, by the applying method or the plasma-CVD method, after depositing the organic compound insulator which uses an organic component as a principal component, plasma-CVD equipment is used on this organic compound insulator, and alkoxy silane, for example, phenyltrimethoxysilane, is made into material gas, and organic component content silicon oxide is formed under oxidizer nonexistence. As an example of the membrane formation conditions of organic component content silicon oxide, RF power:500W, pressure:5torr, flow rate:1 ml/min of phenyltrimethoxysilane, flow rate:5000sccm of Ar, and substrate temperature:400 degree C are mentioned. The membrane formation rates when forming membranes on this condition were 100 nm/min.

[0135] In order to perform the plasma-CVD method which makes alkoxy silane, for example, phenyltrimethoxysilane, material gas according to the 13th operation gestalt, a polymerization reaction occurs in the bottom of the nonexistence of an oxidizer. Therefore, since organic component content silicon oxide can be formed and oxidation of an organic compound insulator can be prevented by the plasma CVD performed by oxidizer nonexistence-ization, the situation which low-molecular gas generates from an organic compound insulator is avoidable.

[0136] After depositing silicon oxide, when the organic compound insulator was observed by FTIR, oxidation of an organic compound insulator was not observed.

[0137] (14th operation gestalt) As 14th operation gestalt of this invention, on the organic compound insulator which uses an organic component as a principal component, alkoxy silane and a silane are used as a raw material and the plasma CVD performed by oxidizer nonexistence-ization explains the formation approach of the insulator layer which forms silicon oxide.

[0138] On a semi-conductor substrate, by the applying method or the plasma-CVD method, after depositing the organic compound insulator which uses an organic component as a principal component, plasma-CVD equipment is used on this organic compound insulator, and alkoxy silane, for example, phenyltrimethoxysilane, and a silane are made into material gas, and silicon oxide is formed under oxidizer nonexistence. As an example of the membrane formation conditions of silicon oxide, RF power:500W, pressure:5torr, flow rate:1

ml/min of phenyltrimethoxysilane, flow rate:500sccm of a silane, flow rate:5000sccm of Ar, and substrate temperature:400 degree C are mentioned. The membrane formation rates when forming membranes on this condition were 300 nm/min.

[0139] In order to perform the plasma-CVD method which makes alkoxy silane and a silane material gas according to the 14th operation gestalt, a polymerization reaction occurs in the bottom of the nonexistence of an oxidizer. Therefore, since silicon oxide can be formed by the plasma CVD performed by oxidizer nonexistence-ization and oxidation of an organic compound insulator can be prevented, the situation which low-molecular gas generates from an organic compound insulator is avoidable.

[0140] After depositing silicon oxide, when the organic compound insulator was observed by FTIR, oxidation of an organic compound insulator was not observed.

[0141] According to the 14th operation gestalt, although the moisture content in silicon oxide increases a little compared with the 13th operation gestalt, a membrane formation rate improves greatly.

[0142] (15th operation gestalt) The formation approach of the organic compound insulator which performs the baking process and biscuit ware process at the time of forming the organic compound insulator which uses an organic component as a principal component by the applying method as 15th operation gestalt of this invention by the reducing atmosphere is explained.

[0143] For example, after applying to the thickness of 300nm the organic film which has the Pori (allyl compound ether) structure, an organic compound insulator is formed by heat-treating to the applied organic film under the reducing atmosphere which consists of mixed gas of nitrogen gas and hydrogen gas, and performing baking and biscuit ware. As conditions for heat treatment, it holds for 30 minutes under the ambient atmosphere of flow rate:2000sccm of the nitrogen gas under the temperature of about 400 degrees C under ordinary pressure, and flow rate:200sccm of hydrogen gas, for example.

[0144] In the former, in the interior of an electric furnace or a hot plate, although it is under ordinary pressure or reduced pressure and heat treatment to the organic film was performed by holding under the ambient atmosphere of the inert gas under the temperature of about 400 degrees C, since it is difficult to hold the interior of an electric furnace or a hot plate in the ambient atmosphere of perfect inert gas, the oxygen of a minute amount will mix in the interior of an electric furnace or a hot plate. Even if the oxygen of a minute amount mixes into the ambient atmosphere holding the organic film under the temperature of about 400 degrees C, the organic film will oxidize easily.

[0145] On the other hand, in the 15th operation gestalt, since it heat-treats by holding the organic film in a reducing atmosphere and baking and biscuit ware are performed, oxidation of an organic compound insulator can be controlled.

[0146] When the organic compound insulator formed by the approach of the 15th operation gestalt was observed by FTIR, oxidation of an organic compound insulator was not observed.

[0147]

[Effect of the Invention] According to the manufacture approach of the 1st semiconductor device of this invention, it is H₂O to an organic compound

insulator. In order to etch by the plasma, since the situation which low-molecular gas, such as a carbon dioxide, generates by the pyrolysis of a carbonyl compound is avoided, on the organic compound insulator after etching, silicon oxide or a metal membrane deposits situation ***** by which a carbonyl compound is generated by oxidization of an organic compound insulator good.

[0148] According to the manufacture approach of the 2nd semiconductor device of this invention, in order to etch by CO plasma to an organic compound insulator, since the situation which low-molecular gas, such as a carbon dioxide, generates by the pyrolysis of a carbonyl compound is avoided, on the organic compound insulator after etching, silicon oxide or a metal membrane deposits situation ***** by which a carbonyl compound is generated by oxidization of an organic compound insulator good.

[0149] Since it is strong compared with association with H and O and extent which O radical contributes to etching is low compared with the manufacture approach of the 1st semiconductor device, the situation where a carbonyl compound is generated by oxidization of an organic compound insulator can be reduced further. [in / in especially association with C and O in CO radical / OH radical] [according to the manufacture approach of the 2nd semiconductor device]

[0150] In order to heat-treat in a hydrogen ambient atmosphere to the organic compound insulator formed by the CVD method according to the formation approach of the 1st insulator layer of this invention, the radical and hydrogen in an organic compound insulator react, and it is -CF2H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen. For this reason, since the situation which low-molecular gas generates by oxidation of an organic compound insulator is avoided, silicon oxide or a metal membrane accumulates good on the organic compound insulator formed by the CVD method.

[0151] In the formation approach of the 1st insulator layer, if it heat-treats in a hydrogen ambient atmosphere, without putting the deposited organic compound insulator to an oxidizing atmosphere, the situation where the radical and oxygen of a carbon compound which were formed by the plasma-CVD method react, and an organic compound insulator oxidizes is certainly avoidable.

[0152] In order to perform hydrogen plasma treatment to the organic compound insulator formed by the CVD method according to the formation approach of the 2nd insulator layer of this invention, the radical and hydrogen radical in an organic compound insulator react, and it is -CF2H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen. For this reason, since the situation which low-molecular gas generates by oxidation of an organic compound insulator is avoided, silicon oxide or a metal membrane accumulates good on the organic compound insulator formed by the CVD method.

[0153] Since a reaction occurs with low energy especially according to the formation approach of the 2nd insulator layer in order that the radical and hydrogen radical in an organic compound insulator may react, compared with the formation approach of the 1st insulator layer, it is low temperature and the radical in an organic compound insulator can be reduced in a short time.

[0154] In the formation approach of the 2nd insulator layer, if hydrogen plasma heat treatment is performed without putting the deposited organic compound

insulator to an oxidizing atmosphere, the situation where the radical and oxygen of a carbon compound which were formed by the plasma-CVD method react, and an organic compound insulator oxidizes is certainly avoidable.

[0155] In order according to the formation approach of the 3rd insulator layer of this invention to heat-treat after pouring in a hydrogen ion to the organic compound insulator formed by the CVD method, the radical and hydrogen in an organic compound insulator react, and it is -CF₂H. Since it is generated, an organic compound insulator is stabilized to oxidation by oxygen. For this reason, since the situation which low-molecular gas generates by oxidation of an organic compound insulator is avoided, silicon oxide or a metal membrane accumulates good on the organic compound insulator formed by the CVD method.

[0156] Since a hydrogen atom is especially spread in an organic compound insulator according to the formation approach of the 3rd insulator layer in order to pour in a hydrogen ion into an organic compound insulator, generating of the radical in an organic compound insulator can be controlled more certainly.

[0157] In the formation approach of the 3rd insulator layer, if a hydrogen ion is poured in without putting the deposited organic compound insulator to an oxidizing atmosphere, the situation where the radical and oxygen of a carbon compound which were formed by the plasma-CVD method react, and an organic compound insulator oxidizes is certainly avoidable.

[0158] Since according to the formation approach of the 4th insulator layer it heat-treats in a hydrogen ambient atmosphere and the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable even if it heat-treats to an organic compound insulator behind after etching into an oxygen ambient atmosphere to an organic compound insulator, silicon oxide or a metal membrane can be deposited good on the organic compound insulator etched into the oxygen ambient atmosphere.

[0159] Since according to the formation approach of the 5th insulator layer hydrogen plasma treatment is performed and the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable even if it heat-treats to an organic compound insulator behind after etching into an oxygen ambient atmosphere to an organic compound insulator, silicon oxide or a metal membrane can be deposited good on the organic compound insulator etched into the oxygen ambient atmosphere.

[0160] Since according to the formation approach of the 6th insulator layer a hydrogen ion is poured in, heat treatment is performed after that, after etching into an oxygen ambient atmosphere to an organic compound insulator and the situation which a carbonyl compound pyrolyzes and low-molecular gas generates is avoidable even if it heat-treats to an organic compound insulator behind, silicon oxide or a metal membrane can be deposited good on the organic compound insulator etched into the oxygen ambient atmosphere.

[0161] Since according to the formation approach of the 7th insulator layer an organic compound insulator is deposited on this substrate film after heat-treating in a hydrogen ambient atmosphere to the substrate film and changing the front face of the substrate film to hydrophobicity, the adhesion of the substrate film and an organic compound insulator improves.

[0162] Since according to the formation approach of the 8th insulator layer an organic compound insulator is deposited on this substrate film after performing

hydrogen plasma treatment to the substrate film and changing the front face of the substrate film to hydrophobicity, the adhesion of the substrate film and an organic compound insulator improves.

[0163] Since according to the formation approach of the 9th insulator layer an organic compound insulator is deposited on this substrate film after pouring in carbon ion to the substrate film, making compatibility with an organic compound insulator high or changing the front face of the substrate film to hydrophobicity, the adhesion of the substrate film and an organic compound insulator improves.

[0164] Since according to the formation approach of the 10th insulator layer an organic compound insulator is deposited on this substrate film after performing heat treatment after pouring in a hydrogen ion to the substrate film, and changing the front face of the substrate film to hydrophobicity, the adhesion of the substrate film and an organic compound insulator improves.

[0165] Since according to the formation approach of the 11th insulator layer organic component content silicon oxide is deposited by the plasma-CVD method which uses alkoxy silane as a raw material and is performed under oxidizer nonexistence on an organic compound insulator and oxidation of an organic compound insulator can be prevented, generating of the low-molecular gas which originates in oxidation of an organic compound insulator and is produced can be prevented certainly.

[0166] Since according to the formation approach of the 12th insulator layer organic component content silicon oxide is deposited by the plasma-CVD method which uses alkoxy silane and a silane as a raw material, and is performed under oxidizer nonexistence on an organic compound insulator and oxidation of an organic compound insulator can be prevented, generating of the low-molecular gas which originates in oxidation of an organic compound insulator and is produced can be prevented certainly.

[0167] Since according to the formation approach of the 13th insulator layer baking and biscuit ware are performed, an organic compound insulator is formed into a reducing atmosphere to the spreading film which consists of an ingredient which uses an organic component as a principal component and oxidation of an organic compound insulator can be prevented, generating of the low-molecular gas which originates in oxidation of an organic compound insulator and is produced can be prevented certainly.

CLAIMS

[Claim(s)]

[Claim 1] It is [the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, and] H₂O to said organic compound insulator. The manufacture approach of the semiconductor device characterized by having etched by the plasma and having the process which patternizes said organic compound insulator.

[Claim 2] The manufacture approach of the semiconductor device characterized

by having the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, and the process which etches by CO plasma to said organic compound insulator, and patternizes said organic compound insulator.

[Claim 3] The formation approach of the insulator layer characterized by having the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and the heat treatment process which heat-treats in a hydrogen ambient atmosphere to said organic compound insulator.

[Claim 4] It is the formation approach of the insulator layer according to claim 3 characterized by for the CVD method in said insulator layer deposition process being a plasma-CVD method, and said heat treatment process including the process which heat-treats in a hydrogen ambient atmosphere to said organic compound insulator, without putting said deposited organic compound insulator to an oxidizing atmosphere.

[Claim 5] The formation approach of the insulator layer characterized by having the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and the plasma treatment process which performs hydrogen plasma treatment to said organic compound insulator.

[Claim 6] It is the formation approach of the insulator layer according to claim 5 characterized by for the CVD method in said insulator layer deposition process being a plasma-CVD method, and said plasma treatment process including the process which performs hydrogen plasma treatment to said organic compound insulator, without putting said deposited organic compound insulator to an oxidizing atmosphere.

[Claim 7] The formation approach of the insulator layer characterized by the insulator layer deposition process which deposits the organic compound insulator which uses an organic component as a principal component on a substrate with a CVD method, and having like ion grouting which performs heat treatment after pouring in a hydrogen ion to said organic compound insulator.

[Claim 8] The CVD method in said insulator layer deposition process is the formation approach of the insulator layer according to claim 7 characterized by being a plasma-CVD method and including the process which pours in a hydrogen ion to said organic compound insulator, without putting said deposited organic compound insulator to an oxidizing atmosphere like said ion grouting.

[Claim 9] The formation approach of the insulator layer characterized by having the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to said organic compound insulator, and patternizes said organic compound insulator, and the process which heat-treats in a hydrogen ambient atmosphere to said patternized organic compound insulator.

[Claim 10] The formation approach of the insulator layer characterized by having the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to said organic compound insulator, and

patternizes said organic compound insulator, and the process which performs hydrogen plasma treatment to said patternized organic compound insulator.

[Claim 11] The formation approach of the insulator layer characterized by having the process which deposits on a substrate the organic compound insulator which uses an organic component as a principal component, the process which etches into an oxygen ambient atmosphere to said organic compound insulator, and patternizes said organic compound insulator, and the process which performs heat treatment after pouring in a hydrogen ion to said patternized organic compound insulator.

[Claim 12] The formation approach of the insulator layer characterized by having the process which deposits the organic compound insulator which uses an organic component as a principal component on the process which heat-treats in a hydrogen ambient atmosphere to the substrate film formed on the substrate, and said substrate film with which heat treatment in a hydrogen ambient atmosphere was performed.

[Claim 13] The formation approach of the insulator layer characterized by having the process which performs hydrogen plasma treatment to the substrate film formed on the substrate, and the process which deposits the organic compound insulator which uses an organic component as a principal component on said substrate film with which hydrogen plasma heat treatment was performed.

[Claim 14] The formation approach of the insulator layer characterized by having the process which pours in carbon ion, and the process which deposits the organic compound insulator which uses an organic component as a principal component on said substrate film with which carbon ion was poured in to the substrate film formed on the substrate.

[Claim 15] The formation approach of the insulator layer characterized by having the process which deposits the organic compound insulator which uses an organic component as a principal component on the process which performs heat treatment, and said substrate film with which heat treatment after hydrogen ion impregnation was performed after pouring in a hydrogen ion to the substrate film formed on the substrate.

[Claim 16] The formation approach of the insulator layer characterized by having deposited organic component content silicon oxide by the plasma-CVD method which uses alkoxysilane as a raw material and is performed under oxidizer nonexistence the process which deposits on a substrate the organic film which uses an organic component as a principal component, and on said organic film, and having the process which forms the insulator layer which consists of said organic film and said organic component content silicon oxide.

[Claim 17] The formation approach of the insulator layer characterized by having deposited organic component content silicon oxide by the plasma-CVD method which uses alkoxysilane and a silane as a raw material, and is performed under oxidizer nonexistence the process which deposits on a substrate the organic film which uses an organic component as a principal component, and on said organic film, and having the process which forms the insulator layer which consists of said organic film and said organic component content silicon oxide.

[Claim 18] The formation approach of the insulator layer characterized by having the process which applies the ingredient which uses an organic component as a principal component, and forms the spreading film on a substrate, and the

process which forms the organic compound insulator which performs baking and biscuit ware and consists of said spreading film into a reducing atmosphere to said spreading film.

[Translation done.]